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THE BORDER PAPERS

Risky Business:

U.S. Border Security and the Threat to Canadian Exports

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In this issue...

As recent border restrictions related to the expected war in Iraq have highlighted, a major share of Canada's exports, jobs and investment are vulnerable to border disruptions due to feared or actual terrorist attacks. The federal government should announce loudly and unequivocally that enhancing security is a top priority.

The Study in Brief

Although fears that security concerns might impede Canada-U.S. trade were prominent after the terrorist attacks of September 11, 2001, there has been little systematic examination of the vulnerability of different Canadian exports to future security-related border disruptions, nor of the challenges those differing exposures present.

This *Commentary* assesses the vulnerability of different Canadian exports and the associated jobs and investment to future security-related border disruptions. We use five criteria to assess this vulnerability: physical characteristics of the exported goods, mode of transport, ease of substitution by U.S. production, time sensitivity and the importance of complementary movements of people to different exports.

Our results suggest that, in the event of future actual or feared attacks, border disruptions threaten key sectors of the Canadian economy — sectors that, by the vulnerability thresholds we select, account for as much as 45 percent of Canadian exports, 390,000 jobs and $3.7 billion of Canadian investment. Ontario, Quebec, Manitoba and PEI have the greatest shares of highly vulnerable exports relative to their total exports. In fact, fears of another terrorist attack led the U.S. to tighten border security on March 18 in advance of its anticipated attack on Iraq.

If this assessment is correct, effective "thickening" of the border by extra security measures could deprive Canada of the advantages — in particular, investment by producers seeking to serve the entire North American market — that trade liberalization has conferred. The federal government, provincial governments and the private sector all have important roles to play in reducing that risk.

The federal government should move ahead with the remaining items on the Smart Border agenda and move key border functions away from the Canada-U.S. frontier. The dangers of an exclusively incremental approach — too low a profile to register with U.S. opinion-makers who see their border with Canada as a security risk; inadequate momentum to overcome bureaucratic inertia — however, suggest the need for forceful statements of support by Canadian leaders. The border will only remain open if U.S. leaders know that Canada treats the security of Americans no less seriously than it treats the security of Canadians. The federal government should announce loudly and unequivocally that maintaining a free flow of goods across the Canada-U.S. border is an integral part of its efforts to enhance North American physical and economic security.

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The Border Papers

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Which Canadian industries are most vulnerable to security-related border closures or disruptions? Which regions are most vulnerable? And who should bear the costs associated with making Canada's exports more secure?

Despite considerable emphasis on facilitating trade across the Canada-U.S. border after the unprecedented terrorist attacks on New York and Washington on September 11, 2001, there has been little systematic examination of the ways in which different Canadian exports are exposed to security-related threats or of the challenges those differing exposures present.

Washington's decision to effectively close the Canada-U.S. border on the day of the attacks, as well as to tighten the border on March 18 in advance of the planned U.S. invasion of Iraq, starkly illustrate Canada's economic vulnerability to security concerns at the border. Drastic border-closing measures and more intensive screening may become standard U.S. procedure, not just in the wake of a future attack, but whenever policymakers receive credible information about the potential for one. The possibility of U.S. defence and protectionist interests finding common ground and erecting new border-crossing constraints in the name of greater domestic security is a threat Canadians must take seriously. Security-related barriers increase the cost of cross-border trade and make locating in Canada less desirable for a business seeking to sell in the U.S. market, costing Canadians many of the advantages that trade liberalization within North America has gained them.

Although several initiatives to keep trade moving and improve security are under way, the sense of urgency on the Canadian side that prevailed immediately after the attacks has dissipated. There has been little if any study of Canadian export vulnerability across the board and Canadians have not discussed the principles that ought to shape enhanced border security nor examined the allocation of the related costs. This *Commentary* takes a close look at a key aspect of this issue — the extent to which security-related disruptions threaten different Canadian industries — and, in light of that assessment, offers some recommendations on how Canada should reduce those threats.

The centrepiece of our investigation is a survey of vulnerability of Canada's exports using a number of criteria, ranging from physical characteristics through ease of substitution by U.S. production to the importance of complementary movements of people to trade in the item in question. We also survey the limited evidence so far available on trade flows, costs, and financial indicators in the wake of the particular events of September 2001. Our vulnerability indexes and these other data allow some tentative conclusions about which sectors are both vulnerable to disruptions and significant to Canada's economy and about the implications for jobs, investment and various regions if actual or threatened border closures occur in the future.

The authors would like to thank Alan Alexandroff, David Andrea, Wendy Dobson, Michael Hart, Jeff Heynen, John Higginbotham, Gary Hufbauer, Stephen Laskowski, Jack Mintz, Reid Morden, Chris Sands, several federal, provincial and U.S. government officials, and the participants in a June 17, 2002, Osgoode Hall Law School seminar on border issues for helpful comments on a previous draft of this paper. Responsibility for any errors is ours alone.

Our principal conclusion is that future border disruptions threaten key sectors of the Canadian economy — areas that, by one set of benchmarks, account for as many as 400,000 jobs and $3.7 billion in Canadian investment annually. In some cases, the presence of a relatively small number of leading companies in an industry suggests that private sector coordination can reduce this vulnerability. In others, however, potential security-related concerns are less amenable to coordinated action, which suggests a role for Canadian governments in facilitating collective action.

Beyond this, we point out that the tight links between — and mutual vulnerability of — Canada and the United States make it legitimate for each partner to insist that the other devote no less attention to the security of citizens on the other side of the border than to the security of its own. At present, many influential parties in the United States feel that Canada does not take security concerns seriously enough. In the event of another threatened or actual terrorist attack, the steps Canada has already undertaken may not protect its economic interests as effectively as if Americans saw Canadians as more enthusiastic security partners. Because many of the needed security measures are incremental changes to existing arrangements that may do little to change this U.S. perception, we expect that Canada will gain more by making a commitment to security part of a higher profile announcement by the Prime Minister, or a broader agreement on North American economic and security integration.

Insecurity and the Canada-U.S. Border

Canadians tend to think of the Canada-U.S. border as a minor impediment to trade and travel. U.S. perceptions, however, are quite different.

September 11, 2001

The terrorist attacks on New York and Washington reminded Canadians that the Canada-U.S. border is a major focus of U.S. security concerns.[1] The fact that the perpetrators of the 1993 bombing of the World Trade Center had links with Canada, that two would-be bombers of the New York City subway in 1997 entered through Canada (cited in Sands 2002a) and that an attack on Los Angeles Airport was foiled at the Canada-U.S. border in late 1999, received much less attention in Canada than in the United States. The U.S. reaction to September 11, however, brought home the fact that when Americans feel threatened, they will treat the Canada-U.S. border as a front line of defence.

Immediately after the September 11 attacks, the United States closed its airports, seaports and land crossings with both Canada and Mexico. When the Canadian and Mexican borders re-opened, U.S. customs officials subjected traffic to intense inspections, delaying trucks for 12-to-18 hours for days afterwards. Some companies on the Canadian side of the border quickly announced shutdowns, with automobile-assembly plants among the first and most seriously affected. It was

1 This paper focuses on security-related disruptions at the border rather than other types of disruptions. Gridlock at the border had long been a problem prior to September 11, 2001 (see, for example, the 2000 Canada-U.S. Partnership Forum report).

weeks before the volume of cross-border traffic returned to pre-September 11 levels.

Though homeland security was a concern prior to September 11, 2001, the attacks made it a top U.S. preoccupation. President Bush appointed a Homeland Security Advisor, with an office across from the Oval Office, and in June 2002 he announced a new Department of Homeland Security, which Congress later approved. In the weeks and months following, U.S. newspapers described weak Canadian border and immigration policies as a security threat, including the false rumour that one or more of the hijackers passed through Canada (Sands, 2002b). Possible Al-Qaeda links to Canada got exposure in U.S. media.[2] Prominent voices urged the U.S. government to improve security by encouraging Canada to tighten its immigration system (see, for example, O'Hanlan et al. 2002, 32).

U.S. media coverage of Canada's so-called lax policies persists, and repercussions affecting the Canada-U.S. border continue. The U.S. *Patriot Act* mandates an entry-exit system by 2005, whereby foreigners will have to sign in and out of the United States when they cross the border. In January 2003, the U.S. Customs Service introduced proposals for transport companies to file cargo data with customs officials 4-to-24 hours before shipments destined to the United States are loaded on trucks and trains, a requirement that would add to the costs of the many Canadian companies that depend on just-in-time logistics. In February 2003, the United States Food and Drug Administration (FDA) proposed requiring a minimum of 12 hours notice before food is imported into the United States.

Foreigners crossing into the U.S. from Canada, transport companies and perhaps food producers will all be affected by proposed new border-protection measures.

Maximizing Physical And Economic Security

Though initially hesitant, Canadian officials reacted to U.S. security concerns when cross-border traffic began to seize up. The federal government followed up its statements about Canada's intention to establish more rigorous vetting of immigrants and refugee claimants with an additional $9 million to increase the number of employees assigned to front-end examination and security screening, more detailed scrutiny of refugee claimants already in Canada and increased detention and deportation activity.[3] The December 2001 federal budget contained new money for policing and infrastructure along the border and the Canada-U.S. Smart Border Declaration (SBD) of December 2001 outlined 30 actions designed to create a "North American zone of confidence."[4] Canadian officials developed

2 As in "U.S. Identifies a Canadian as taker of martyrdom pledge," *New York Times* on-line edition. January 26, 2002.

3 Citizenship and Immigration Canada. News Release. October 12, 2001. Further information on the Canadian government's actions in response to the attacks of September 11, 2001, is available on the Government of Canada website at http://canada.gc.ca/united-states/security_e.html.

4 Many of these actions were discussed between the two governments prior to September 11, 2001. A confidential Canadian government memorandum on March 8, 2000, enumerates many of the joint security measures contained in the SBD, including joint investigations and operations, intelligence sharing, coordination of visas, asylum and removals issues and front-end refugee screening. It also referred to $354 million in expected funding between 1999 and 2003 on these and other initiatives. The request under the *Access to Information Act* was made by lawyer Richard Kurland and published in the October 2002 edition of Lexbase (Rekai, 2002).

many of these joint solutions — understandable, considering Canada's greater vulnerability to disruptions at the border.

U.S. security concerns do not rank high in Canadian polls, however, and the passage of time without another serious terrorist act inside North America reduced the sense of urgency surrounding this issue in Canada. Though many of the Smart Border adenda items have been implemented, often despite some U.S. resistance,[5] remaining obstacles to the movement of goods, services and people across the border — such as the new entry-exit requirement — are being addressed piecemeal. If flagging interest impedes progress toward measures that both improve security and are seen by Americans to do so, another incident could cause a more serious and persistent jam at the border, resulting in layoffs and depressing output in Canada in the short run, while discouraging investment — with more profound consequences for Canadian prosperity — in the long run.

Assessing Canadian Vulnerability

How vulnerable is Canada to future security-related disruptions of cross-border traffic? We start our exploration of this question with some basic background on cross-border trade. We then assess the characteristics of exports that make them more or less vulnerable to security-related disruptions. We next use the post-September 11, 2001, disruption as a test — albeit an inexact one — of the actual impact that security-related disruptions could have on the border, looking at export volumes, aggregate revenues and expenditures in various industries, as well as equity-market data. Finally, we attempt to draw links back from key affected exports to output, employment and investment to discern their importance to the national and regional economies.

Background on Canada-U.S. Trade

As many Canadians are aware, the United States and Canada have the world's largest bilateral trading relationship. In 2001, Canada exported an estimated $350 billion in goods to the United States, while importing $218 billion in goods. Service exports to the United States amounted to $33 billion, while imports totalled $39 billion.

Since September 11, 2001, the United States has focussed more on security concerns than on trade. While U.S. trade with Canada is large in dollar terms and cross-border trade is highly integrated, making disruptions painful to both sides,[6] it is not surprising that Canadians have paid more attention to economic matters.

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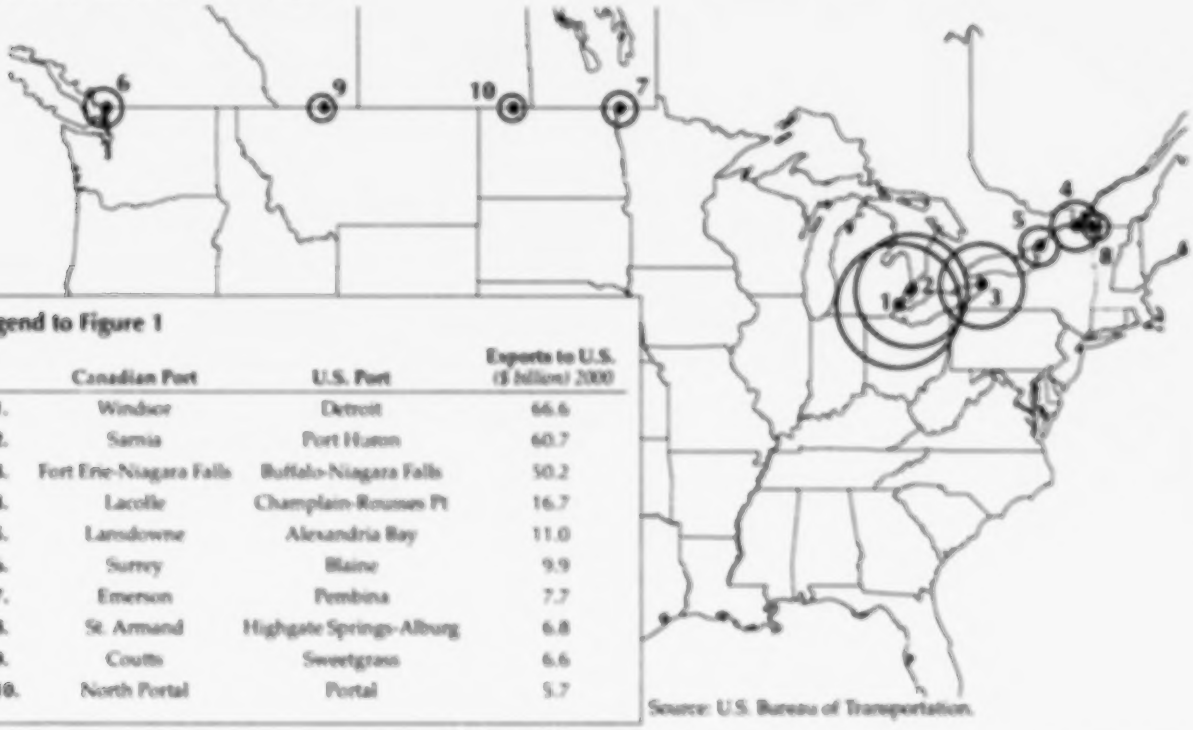
5 In late January 2002, for example, Robert Bonner, the commissioner of the U.S. Customs Service, opposed plans to pre-clear low-risk trucks before they reach the border (see "Canada wants some trucks exempt from border inspection," New York Times, February 1, 2002). Bonner has generally emphasized security over trade, while Secretary of Homeland Security and former Homeland Security Advisor Tom Ridge has been a stronger proponent of risk management and trade facilitation.

6 One piece of evidence of the degree of cross-border integration is that in 1998, exports and imports within the same industries accounted for the majority of trade in almost all commodity groupings (Sawchuk and Sydor, 2002).

Figure 1: Top Ten Border Crossings



Legend to Figure 1

	Canadian Port	U.S. Port	Exports to U.S. ($ billion) 2000
1.	Windsor	Detroit	66.6
2.	Sarnia	Port Huron	60.7
3.	Fort Erie-Niagara Falls	Buffalo-Niagara Falls	50.2
4.	Lacolle	Champlain-Rouses Pt	16.7
5.	Lansdowne	Alexandria Bay	11.0
6.	Surrey	Blaine	9.9
7.	Emerson	Pembina	7.7
8.	St. Armand	Highgate Springs-Alburg	6.8
9.	Coutts	Sweetgrass	6.6
10.	North Portal	Portal	5.7

Source: U.S. Bureau of Transportation.

Eighty-six percent of total Canadian exports of goods go to or through the United States; U.S. goods exports to Canada represent 23 percent of the U.S. total. Canada receives 73 percent of its imports from the United States; the corresponding figure on the U.S. side is 19 percent.[7] Canadian exports to the United States represent almost 40 percent of Canadian gross domestic product (GDP), while exports from the United States to Canada represent around three percent of U.S. GDP.

Canada's greater trade dependence has long made reductions in barriers at the Canada-U.S. border a priority in economic policymaking, with the 1965 Auto Pact, the 1989 Canada-U.S. Free Trade Agreement and the 1994 North American Free Trade Agreement (NAFTA) being signal efforts in that regard. The border still matters, however. Because the Canadian and U.S. economies are similar in many respects, with parallel resource endowments in the west and similar industrial profiles in the east, north-south trade volumes are highly sensitive to costs at the border (Fairfield, 2001).

A relevant fact about Canadian exports to the United States is that over 60 percent of them originate in Ontario. Together, Ontario, Quebec and British Columbia shipping points accounted for 88 percent of exports in 1999. Although there are an estimated 75 land ports along the border, most vehicle crossings occur on the Ontario-Michigan and Ontario-New York borders, as well as on the British Columbia-Washington border (Canada, 2001). Figure 1 shows the top 10 land

7 http://www.usembassycanada.gov/.

border crossings — by truck, rail and pipeline — with the size of each "bubble" representing the value of Canadian exports at each crossing in 2000.[8]

The map highlights the concentration of cross-border export value in Ontario, where the Great Lakes limit the availability of land crossings.

The Nature and Vulnerability of Canadian Exports

We now turn to an assessment of the vulnerability of Canadian exports to border disruptions. Our explicit focus is vulnerability of exports of goods to security concerns at the border.[9]

We rank Canadian exports to the U.S. against five characteristics that affect their vulnerability to security-related border disruptions.

1. Physical Characteristics. The ease with which a terrorist could introduce a threatening substance or device into a shipment without detection affects the item's vulnerability to a border disruption. Electricity creates no such opportunities. Also relatively invulnerable are oil and natural gas in pipelines. Homogenous items shipped in bulk that are easy to inspect, such as grains, are one step further along this spectrum. Relatively vulnerable are large, complicated machines that offer greater opportunities to hide dangerous substances or devices, or certain foods that are difficult to inspect or are packaged in ways that make inspection cumbersome.

2. Mode of Transport. Exports can be shipped by truck, ship, air, rail, mail, pipelines and power lines, all representing different probabilities of disruptions at the border. Transport through electricity power lines and pipelines represent modes that are unlikely to cause a border disruption. Highly vulnerable are goods transported by truck, which are difficult to inspect thoroughly[10] and are

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8 We use data from the U.S. Bureau of Transportation on the volume of U.S. imports at each border crossing. Statistics Canada data on Canadian exports are organized by port of clearance, not port of entry, which means, for example, that goods that physically cross the border at Detroit-Windsor may be recorded as having entered at Toronto's Pearson airport.

9 This focus keeps the discussion manageable, but neglects some important potential disruptions to commerce. Oil and gas pipelines and electricity cables, for example, are economically important potential targets of terrorism, but securing them is a very different task from managing flows at the border. Another physical flow from Canada to the United States that might create vulnerability to terrorist attack is Canadian garbage going to U.S. disposal sites — technically speaking, however, this is an import by Canadians of a service from the United States. A further limitation of our analysis is its inability to precisely measure Canadian service exports. Data on service exports are highly aggregated (at the 1-2 digit Standard Industrial Classification level), inhibiting a breakdown fine-grained enough to enable us to distinguish between those, such as transport services, that are highly vulnerable to border disruptions and others that are almost untouchable. Services that must be delivered face-to-face and at a particular time, such as a musical performance, will suffer more from border disruptions than those that must be delivered face-to-face, but where several hours of delay does not appreciably affect usefulness to the buyer. The latter are more vulnerable than services where personal contact is desirable but not essential; least vulnerable of all are services, such as data processing, that do not require anyone to cross the border. Sorting these categories out remains a task for the future.

10 It requires, on average, five inspectors three hours to conduct a thorough physical inspection of an 18-wheel truck (Flynn, 2002).

susceptible to delays because they share roads with other traffic that may slow them even when they are carrying clearly harmless loads.[11] Since most truck crossings are concentrated at a few points and routes to alternative crossings can quickly congest, much cross-border truck traffic is vulnerable to hold-ups arising from only a small portion of shipments.

Sea transport is also extremely vulnerable. Container documentation typically provides only sketchy details about contents, sender and ultimate recipient (Flynn, 2002), and suspicions about one container on a vessel could affect all containers on that vessel. Despite security upgrades since late 2001, air transport remains highly vulnerable, as the closure of air space for four days following the terrorist attacks showed. Rail is somewhere in the middle. Though trains have a limited number of operators and run on dedicated corridors which are relatively simple to monitor, containers are often not well-tracked and may sit idle in rail yards where they could be tampered with, while the inspection of one container on a train delays all shipments on that train.

3. Time Sensitivity. Vulnerability also depends on the degree to which delays render various items less useful to the buyer, either because of changes in the product itself or because of production or sales processes. Less vulnerable are shipments of minerals or grains, where inventories are inexpensive to carry and production processes are easier to speed up or slow down. Highly vulnerable are fresh meat, perishable fruits and vegetables that cannot physically survive delays, components for industries that operate on a just-in-time basis — automobile assembly being a key example[12] — and inputs into production processes that are difficult to adjust in the face of disruption, as is the case with many chemical industries.[13]

4. People Sensitivity. Some exports are vulnerable by virtue of the centrality of movements of people to their usefulness. Most raw materials and manufactures are useful to buyers out-of-the-box and require no human expertise to accompany them. Some manufactures, however, depend on a regular flow of engineers to support production. And capital goods often require people to accompany them to provide installation and service support.

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11 Our classifications are obviously made according to current practices, which are subject to both regulatory and behavioural changes. For example, one source of vulnerability to delays for goods transported by truck arises from Canadian regulations that require truck drivers to switch shifts after eight hours, even if those eight hours are spent idling at the border. Current U.S. customs proposals requiring transport companies to file shipment details 4-to-24 hours before trucks and trains arrive at the border will also affect the vulnerability of goods shipped by certain modes of transport. As for behaviour, shippers of vulnerable goods may switch modes or crossing points if delays appear likely.

12 Automotive parts are frequently delivered to a plant across the border within hours of an order — an engine leaving the Ford Motor Co. plant in Windsor, Ontario, will typically be in a vehicle in Michigan four hours later. Successful integration of parts, such as seats, depends on tight adherence to a just-in-time production schedule and is vulnerable to border disruptions (Andreu and Smith, 2002). The Canadian Vehicle Manufacturers Association estimates that unplanned production losses resulting from parts shortages cost manufacturing facilities $1-to-$1.5 million per hour (Canada, 2001).

13 We note, though we do not pursue the idea, that dependence on imported components that may themselves be subject to disruption at the border may increase the vulnerability of some exports.

5. Location Sensitivity. The final source of vulnerability we consider arises from the ease with which U.S. products could substitute for Canadian products.[14] We adopt a two-year time frame as a sensible period for thinking about such shifts of production, since many contracts and production cycles make shifts within a year problematic even when no physical constraint exists. Least vulnerable would be products, such as furs, for which Canada's climate or natural resources provide unique advantages, energy or products that are in short supply in the United States by virtue of capacity constraints (although these assessments are obviously sensitive to the state of U.S. demand) and highly concentrated industries with geographically dense networks of related industries. More vulnerable are manufactures and services that are produced under similar conditions on both sides of the border, often by the same companies, and for which U.S. producers could easily step up their output to replace supplies from Canada.

To develop an overall measure of vulnerability to border disruptions, we assign values to each export category on a scale of one (invulnerable) to ten (highly vulnerable) for each of the five measures.[15] Our measure of overall vulnerability is simply an arithmetical average of the five. Since we categorize as vulnerable those industries that would be directly affected by security concerns, we exclude at this point those that are indirectly affected — energy providers to auto manufacturers, for example — though we take up this aspect of vulnerability later.

Auto assembly and auto parts makers would be particularly vulnerable to new border closures.

Table 1 shows our vulnerability figures for the top 30 exporting industries ranked by value of domestic exports (i.e., excluding re-exports) in 2001.[16] Appendix A shows values for all 109 export categories.

Our preliminary assessment of Canada's priorities in thinking about border security emerges from Figure 2, which ranks all U.S.-bound exports worth more than $10 million in 2001 by vulnerability scores on its horizontal axis and by value on its vertical axis. The shaded area represents those industries that rank above 6.5 on our vulnerability index and exported more than $1 billion in 2001. This figure provides a convenient snapshot of the areas where Canadian policy ought to emphasize improving the resilience of border shipments to terrorist threats; industries in the "hot corner" of the figure are those that are both highly vulnerable and highly valuable.[17]

The 25 industries represented in the "hot corner" — out of a total of 109 industries that export goods — represent 45 percent of total domestic goods exports from Canada to the United States. Not surprisingly, auto assembly and parts manufacturing figure prominently. Many of the other industries represented

14 Other countries, Mexico in particular, can also fill U.S. demand unsatisfied by Canadian suppliers, but it seems reasonable to assume that security-related disruptions in trade will be at least as great for Mexico as for Canada.

15 We base our mode of transport values on transport data available from Transport Canada. These data are in categories more aggregated than our export categories, necessitating some judgement on our part.

16 Data provided by Statistics Canada on Canada's exports to the United States are overstated because they include some shipments to third countries via the United States. Even though these "transhipments" should not technically be counted in Canada-U.S. trade, the exports still matter to output and jobs in the Canadian economy and are appropriately included in our analysis.

17 The descriptions of the mnemonics for each industry are in Appendix A.

Table 1: *Vulnerability of Top 30 Export Industries to Security-Related Border Disruptions*

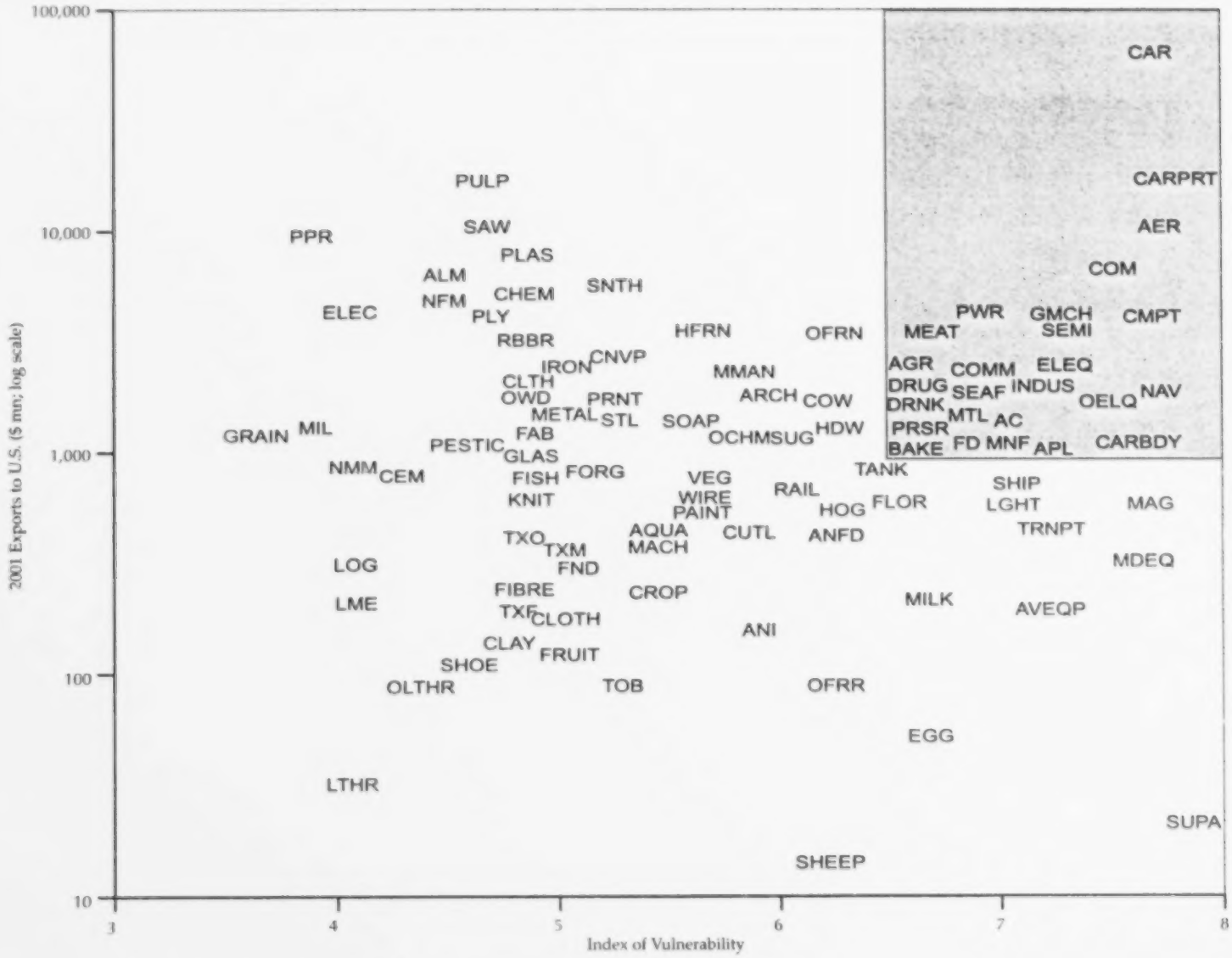
Industry*	Exports (in 2003)	Physical Security	Mode of Transport	Time Sensitivity	People Sensitivity	Location Sensitivity	Overall Index of Vulnerability
	($ billions)			*(measure of vulnerability)**			
Motor vehicle manufacturing	62.8	7	10	9	6	9	8
Oil and gas extraction	61.9	0	0	10	0	0	3
Motor vehicle parts manufacturing	16.8	7	10	10	6	9	8
Pulp, paper, and paperboard mills	16.5	6	10	3	2	6	5
Sawmills and wood preservation	10.2	6	10	3	2	6	5
Aerospace product and parts manufacturing	10.2	7	10	8	3	9	8
Petroleum and coal products manufacturing	9.3	9	8	3	2	3	6
Plastic products manufacturing	7.6	3	7	3	2	7	5
Communications equipment manufacturing	6.6	7	10	8	6	9	8
Alumina and aluminum production and processing	6.2	3	7	6	3	3	5
Resin, synthetic rubber, artificial and synthetic fibre, and filament manufacturing	5.5	3	6	7	2	7	5
Basic chemical manufacturing	5.1	6	7	7	2	5	5
Nonferrous metal (except aluminum) production and processing	4.7	3	7	6	2	3	5
Electric power generation, transmission, and distribution	4.2	1	1	9	1	9	4
Engine, turbine, and power transmission equipment manufacturing	4.2	7	10	7	6	7	7
Veneer, plywood, and engineered wood product manufacturing	4.0	6	10	3	1	6	5
Computer and peripheral equipment manufacturing	4.0	7	10	9	6	9	8
Other general purpose machinery manufacturing	3.9	9	10	7	6	7	7
Semiconductor and other electronic component manufacturing	3.5	7	10	9	6	7	7
Household and institutional furniture and kitchen cabinet manufacturing	3.5	7	8	3	2	7	6
Meat product manufacturing	3.4	7	10	9	1	7	7
Office furniture (including fixtures) manufacturing	3.4	7	10	6	2	7	6
Rubber product manufacturing	3.1	3	7	3	1	7	5
Converted paper product manufacturing	2.5	3	10	3	1	6	5
Electrical equipment manufacturing	2.4	9	10	8	3	7	7
Iron and steel mills and ferroalloy manufacturing	2.4	3	7	3	2	7	5
Other miscellaneous manufacturing	2.3	7	8	6	2	7	6
Commercial and service industry machinery manufacturing	2.2	9	10	3	6	7	7
Metal ore mining	2.0	6	6	3	1	1	3
Agricultural, construction, and mining machinery manufacturing	2.0	9	10	3	2	7	7

* Industry description according to the four-digit level North American Industrial Classification System (NAICS).

* Vulnerability is measured on a scale of 1 (invulnerable) to 10 (highly vulnerable).

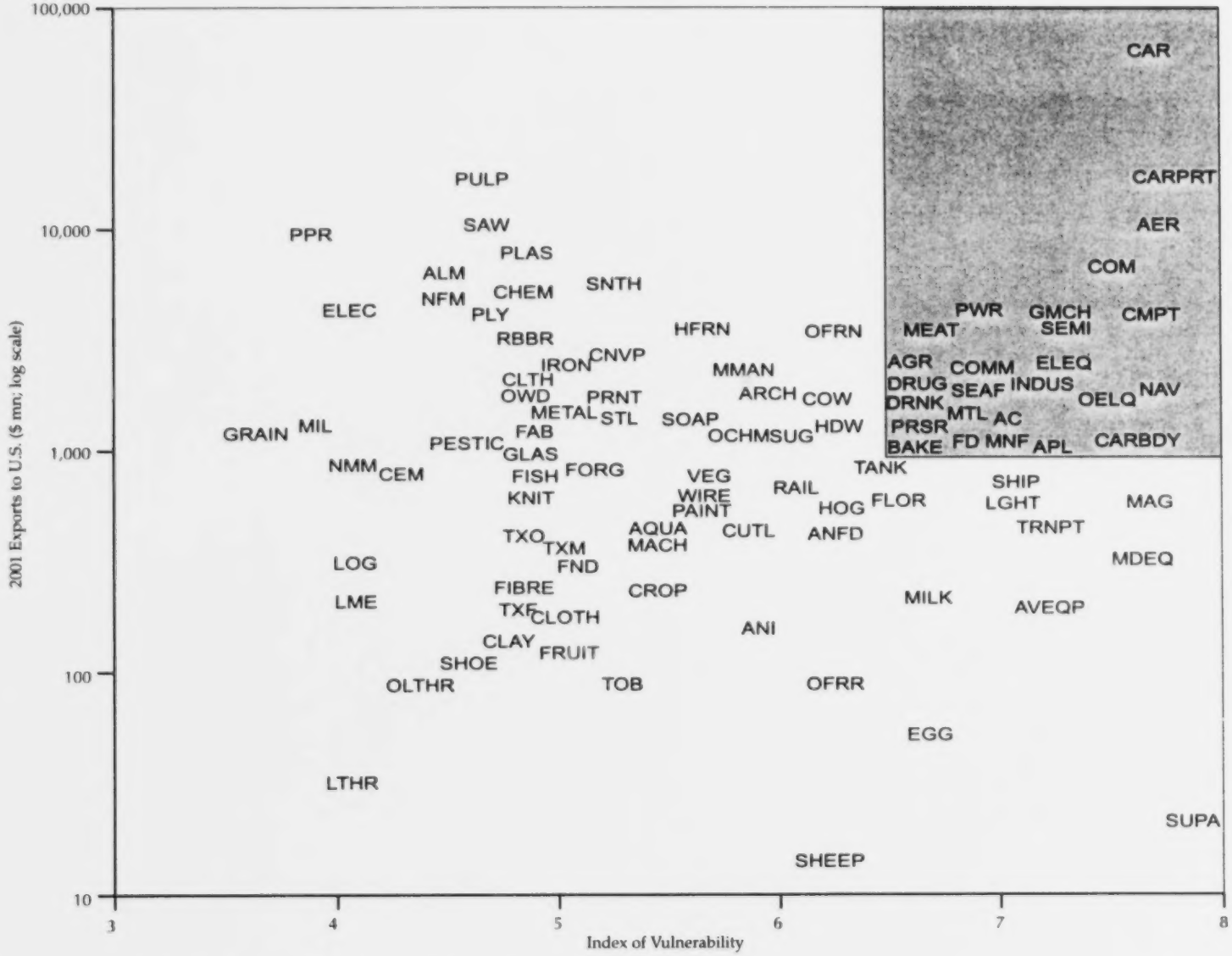
Sources: Industry Canada Trade Data Online; authors' calculations.

Figure 2: Vulnerability and Export Value



Sources: Industry Canada "Trade Data Online"; authors' calculations. Mnemonics are listed in Appendix A.

Figure 2: Vulnerability and Export Value



Sources: Industry Canada "Trade Data Online"; authors' calculations. Mnemonics are listed in Appendix A.

Table 2: ***Export Intensities for "Hot Corner" Industries***

Industry[a]	Export Intensity, 1999[b]
	(%)
Fruit and vegetable preserving and specialty food manufacturing	25
Meat product manufacturing	25
Seafood product preparation and packaging	76
Bakeries and tortilla manufacturing	21
Other food manufacturing	22
Beverage manufacturing	17
Pharmaceutical and medicine manufacturing	33
Agricultural, construction, and mining machinery manufacturing	50
Industrial machinery manufacturing	92
Commercial and service industry machinery manufacturing	100
Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	60
Metalworking machinery manufacturing	58
Engine, turbine, and power transmission equipment manufacturing	100
Other general-purpose machinery manufacturing	74
Computer and peripheral equipment manufacturing	100
Communications equipment manufacturing	78
Semiconductor and other electronic component manufacturing	53
Navigational, measuring, medical, and control instruments manufacturing	55
Household appliance manufacturing	57
Electrical equipment manufacturing	79
Other electrical equipment and component manufacturing	54
Motor vehicle manufacturing	88
Motor vehicle body and trailer manufacturing	27
Motor vehicle parts manufacturing	64
Aerospace product and parts manufacturing	75

[a] Industry description according to the four-digit-level NAICS.

[b] Data on export intensity are combined from two different sources that are not fully comparable.

Source: Industry Canada Trade Data Online.

in the upper right corner involve machinery and equipment manufacturing. These include aerospace, communications and semi-conductor equipment, computers and industrial machinery. The highly integrated, time-sensitive nature of these industries, combined with the relative ease with which U.S. production could fill gaps in the medium term, make delays at the border a significant threat to current Canadian exports and to future Canadian investment.

Though the most valuable and vulnerable exports tend to be machinery and equipment manufactures, various food products, especially meat and seafood, are also both vulnerable and valuable. There is nothing unique about Canadian locations for food processing and many manufacturing processes are highly integrated cross-border — for example, Dairy Queen in the United States makes key ingredients for its ice cream cakes in Canada.

The Economic Consequences of Border Vulnerability

Dollar values of vulnerable exports are likely to be closely related to other measures that Canadians care about: jobs, incomes and investment. For a given degree of border vulnerability, jobs, incomes and investment will be more exposed to disruption in industries that export larger shares of their output. As it happens, 92 percent of the export value of the highly vulnerable and valuable industries

Table 3: ***Estimates of Output Indirectly Associated with Vulnerable Exports***

Industry[a]	Inputs to Production Process (Including Imports), 1998 (1)[b]	Import Content of Inputs, 1995 (2)	Average Export Intensities, 1999[c] (3)	Estimate of Indirectly Associated Production (4)[d]
	($ millions)	*($ millions)*	*(%)*	*($ millions)*
Crop and animal production	34,848	6,621	n/a	
Fruit and vegetable preserving and specialty food manufacturing	4,810	1,106	25	934
Meat product manufacturing	14,427	3,318	25	2,737
Seafood product preparation and packaging	3,157	726	76	1,845
Miscellaneous food manufacturing	15,185	3,493	21	2,489
Beverage manufacturing	13,267	3,051	17	1,746
Pharmaceutical and medicine manufacturing	5,371	1,343	33	1,320
Machinery manufacturing	23,449	12,193	76	8,580
Computer and peripheral equipment manufacturing	5,386	1,885	100	3,501
Electronic product manufacturing	20,601	9,476	75	8,333
Household appliance manufacturing	1,892	662	57	700
Electrical equipment and component manufacturing	7,286	2,550	66	3,138
Motor vehicle manufacturing	59,117	33,697	88	22,449
Motor vehicle body and trailer manufacturing	2,691	1,534	27	309
Motor vehicle parts manufacturing	26,326	15,006	64	7,295
Aerospace product and parts manufacturing	9,784	3,424	75	4,758
Total				70,131

[a] Industry description according to the NAICS.

[b] Inputs refer to the total value of commodities consumed as an input to each industry's production; 1998 is the latest year available for input data. Categories for input data are sometimes available only at a higher level of aggregation than the NAICS four-digit categories. Therefore, in a small number of cases, not all industries in a given input grouping are highly vulnerable and valuable. In such cases, figures on indirectly vulnerable production are overestimates.

[c] Data on export intensity are combined from two different sources that are not fully comparable.

[d] The estimate of indirectly associated production is column 3 multiplied by the difference between column 1 and column 2.

Source: Statistics Canada, Input-Output Division; authors' calculations.

identified has export intensities of 50 percent or more (Table 2).[18]

Indirect Effects

Our aggregate measures of vulnerability may underestimate the true impact of potential disruptions on Canada because they take into account only those exports that are directly vulnerable. A variety of industries, however, contribute to the exports of vulnerable industries and would also be affected by any serious disruption. Using Statistics Canada's input-output tables, we perform a rough calculation of the use of other domestic resources by highly vulnerable industries by multiplying export intensities by the value of inputs associated with each highly vulnerable and valuable industry (subtracting the portion of inputs that are imports). Table 3 shows the results.

This admittedly rough calculation suggests that $70 billion in production is indirectly vulnerable, compared with $141 billion in exports that are associated

18 The export intensity measure is for overall exports, not just exports to the United States. However, because of the dominance of the U.S. market in Canadian exports for most industries, the figures should be representative. Inconsistencies in the data sources used by Statistics Canada to calculate export intensity mean that the data should be interpreted with caution. (Some values slightly exceed 100 percent; we have rounded those numbers down to 100 percent.)

with the directly vulnerable industries. Not too much weight should be placed on this exact number as the input-output data and the trade data do not match perfectly industry-by-industry.[19] It seems reasonable to interpret the result as an upper bound on the magnitude of vulnerability, rather than its precise value, because these industries contribute to non-exported goods, as well, and would require less adjustment than those directly vulnerable.

Employment and Earnings

Combining data on employment in the industries most at risk with measures of export intensity provides a rough estimate of the number of jobs potentially affected. Matching employment data are available for 21 out of the 25 industries in the "hot corner" of Figure 2. Table 4 provides estimates of the number of jobs that are associated with these at-risk industries through multiplying each one's export intensity by the number of employees in that industry.[20]

The highest number of vulnerable jobs is in auto and parts manufacturing, followed by aerospace parts, general-purpose machinery manufacturing and seafood-product manufacturing. The 21 vulnerable industries for which we have employment data represent 23 percent of total employment for all goods-producing industries. If the ratio of exports to employees is the same in the four valuable and vulnerable industries for which we have no separate employment data, the total jobs represented by the products in the upper right corner of Figure 2 would be about 390,000. Based on our earlier rough calculation that found a 2:1 ratio of direct to indirect vulnerability, a maximum of about 200,000 jobs may be indirectly vulnerable.

Investment

Another natural focus of concern is investment. If security concerns make the border more of an obstruction to commerce, some companies that previously planned to produce in Canada to serve their U.S. operations or their U.S. consumers may add to their capacity in the United States instead. Although a less permeable border might tip some location decisions the other way — as would be the case if a supplier to a Canadian assembly plant feared delays of time-sensitive shipments — the greater size of the U.S. market makes this risk far greater for Canada than for the United States.

Table 5 shows, in similar fashion to the jobs data in Table 4, estimates of the amount of Canadian capital expenditures associated with the highly valuable and

19 The import-content data are more highly aggregated than both the trade and input-output data and matching required some judgement on our part. We also note that the input-output figures we use may include some double counting.

20 Output per worker tends to be higher in exporting industries (Cameron 1999 estimates the margin at one-third in 1995). If this contrast holds within industries — that is, if output per worker is higher in companies producing a given good for export than in those producing it for the domestic market, Table 4 will somewhat overstate the number of jobs at risk. The toll in terms of wages and salaries would, in either case, be more proportional to the export intensities.

Table 4: ***Jobs "at Risk"***

Industry[a]	Employment,[b] 2000 (1)	Export Intensity, 1999 (2)	Estimated Number of Jobs "at Risk" (1) × (2)
	(number of jobs)	*(%)*	
Fruit and vegetable preserving and specialty food manufacturing	25,206	25	6,357
Meat product manufacturing	56,545	25	13,933
Seafood product preparation and packaging	30,535	76	23,173
Bakeries and tortilla manufacturing	42,874	21	8,888
Other food manufacturing	25,326	22	5,531
Beverage manufacturing	30,298	17	5,178
Pharmaceutical and medicine manufacturing	23,755	33	7,782
Agricultural, construction, and mining machinery manufacturing	23,749	50	11,832
Industrial machinery manufacturing	18,281	92	16,744
Commercial and service industry machinery manufacturing	4,387	100	11,387
Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	7,582	60	4,565
Metalworking machinery manufacturing	26,530	58	15,425
Engine, turbine, and power transmission equipment manufacturing	21,681	100	21,681
Other general-purpose machinery manufacturing	35,203	74	25,987
Computer and peripheral equipment manufacturing	14,669	100	14,669
Communications equipment manufacturing	26,695	78	20,908
Semiconductor and other electronic component manufacturing	27,371	53	14,583
Navigational, measuring, medical, and control instruments manufacturing	28,149	55	15,443
Household appliance manufacturing	7,511	57	4,275
Electrical equipment manufacturing	20,037	79	15,759
Other electrical equipment and component manufacturing	18,499	54	9,962
Motor vehicle manufacturing	54,556	88	48,178
Motor vehicle body and trailer manufacturing	5,597	27	1,493
Motor vehicle parts manufacturing	98,154	64	63,250
Aerospace product and parts manufacturing	49,073	75	36,716
Estimated total			386,981

[a] Industry description according to the four-digit-level NAICS.

[b] Where employment figures are unavailable, we estimate employment assuming the ratio of exports to employees is the same as in other "at risk" industries.

Sources: Statistics Canada, Survey of Employment, Payroll and Hours; Industry Canada Trade Data On-line; authors' calculations.

vulnerable industries. We estimate that $3.7 billion of annual Canadian investment is associated with the export portion of the at-risk industries.[21] Again, based on a 2:1 ratio of direct to indirect effects, just under $2 billion of investment might be indirectly at risk.

The Regional Dimension

Another chronic Canadian concern is regional differences in economic prosperity. Industries of different degrees of vulnerability are not uniformly distributed across the country, suggesting that some regions are more vulnerable to disruptions of border commerce than others. Table 6 shows a breakdown by

21 For foreign direct investment (FDI), there are no data available in the same categories as our trade data, and the most highly disaggregated data available only yield 17 categories. We focus here on Canadian capital expenditures rather than FDI because total FDI figures do not capture the differences between green-field investment, which creates new jobs and output in Canada, and purchases of existing assets.

Table 5: *Canadian Investment "at Risk"*

Industry[a]	Capital Spending Intentions, 2003 (1)	Export Intensity (2)	Estimated Annual Investment "at Risk" (1) × (2)
	($ millions)	*(%)*	*($ millions)*
Fruit and vegetable preserving and speciality food manufacturing	247	25	62
Meat product manufacturing	246	25	61
Seafood product preparation and packaging	57	76	43
Bakeries and tortilla manufacturing	193	21	40
Other food manufacturing	116	22	25
Pharmaceutical and medicine manufacturing	592	33	112
Agricultural, construction, and mining machinery manufacturing	79	50	39
Industrial machinery manufacturing	50	92	46
Commercial and service industry machinery manufacturing	77	100	77
Ventilation, heating, air conditioning, and commercial refrigeration equipment manufacturing	39	60	23
Metalworking machinery manufacturing	73	58	42
Engine, turbine, and power transmission equipment manufacturing	48	100	48
Other general-purpose machinery manufacturing	101	74	75
Computer and peripheral equipment manufacturing	121	100	121
Communications equipment manufacturing	210	78	164
Semiconductor and other electronic component manufacturing	241	53	128
Navigational, measuring, medical, and control instruments manufacturing	124	55	68
Household appliance manufacturing	50	57	29
Electrical equipment manufacturing	43	79	33
Other electrical equipment and component manufacturing	85	54	46
Motor vehicle manufacturing	2,174	88	1,920
Motor vehicle body and trailer manufacturing	46	27	12
Motor vehicle parts manufacturing	561	64	361
Aerospace product and parts manufacturing	234	75	175
Total			3,660

[a] Industry description according to the four-digit-level (NAICS).

Note: Since investment data classifications do not accord one-to-one with four-digit NAICS export data, the categories here do not correspond exactly with those in other figures and tables. For example, beverage manufacturing is excluded from this table because capital spending data are available only as part of NAICS three-digit aggregates. Data are calenderized and expressed in current dollars.

Sources: Industry Canada, Trade Data On-line; Statistics Canada, Survey of Investment Intentions; authors' calculations.

province of the dollar value of exports in categories with vulnerability rankings greater than 6.5, as well as these values as percentages of both total provincial exports and output.[22]

Not surprisingly, given Ontario's weight in exports to the United States and the importance of manufacturing (which we rate as relatively vulnerable) in those exports, Ontario ranks first in terms of export value at risk, not just in absolute dollars, but also when value at risk is scaled to total exports or provincial GDP. Highly vulnerable exports also matter greatly to Quebec and Manitoba, constituting 46 and 38 percent respectively of provincial exports. British Columbia, Alberta and Saskatchewan appear to rely more on exports that are less time-sensitive, such as lumber, or cross the border in more secure forms, such as fossil fuels in pipelines.

22 We note again that these trade data are customs-based: they capture the province from which exports were shipped, rather than the province of origin. They may, therefore, overestimate the vulnerability of exports from Ontario, Quebec and British Columbia, and underestimate that of exports from other provinces. In the case of exports that are vulnerable because of time- or people-sensitivity, trans-shipment and therefore the size of this bias will be less important.

Table 6: ***Vulnerability by Province***

	Exports above Vulnerability of 6.5	Exports "at Risk" as a Proportion of Provincial Output	Exports "at Risk" as a Proportion of Provincial Exports	Estimated Number of Jobs "at Risk"
	($ millions)	*(%)*	*(%)*	
Newfoundland and Labrador	465	4	22	600
Prince Edward Island	417	15	79	500
Nova Scotia	648	3	14	500
New Brunswick	864	5	12	600
Quebec	22,809	11	41	56,400
Ontario	108,321	28	68	624,600
Manitoba	2,503	8	35	1,300
Saskatchewan	559	2	8	400
Alberta	5,453	5	11	6,400
British Columbia	3,221	3	15	1,700

Note: For the provincial analysis, we examine all categories over 6.5 on the vulnerability index. We do not set out a dollar value threshold as we do for the national analysis. Therefore, the numbers in this table do not correspond directly to the national numbers.

Sources: Statistics Canada; authors' calculations.

The vulnerability of the Atlantic provinces varies. We estimate that time-sensitive seafood exports dominate the highly vulnerable category. Just over one-fifth of Newfoundland's exports are highly vulnerable. Almost four-fifths of Prince Edward Island's exports — in which food preserving and specialty foods are important and which we judge are potentially substitutable by U.S. production — fall into this category. Nova Scotia and New Brunswick's exports are more diversified, putting those provinces less at risk.

There are no regional input/output data to enable calculations of indirect vulnerability on a provincial basis, but rough estimates can be calculated based on a 2:1 ratio of direct to indirect effects. A further dimension of vulnerability shown in Table 6, somewhat speculatively, is provincial jobs at risk.[23] We expect that investment would follow the same pattern as exports and employment, with the worst effects as a share of provincial exports in Ontario, Quebec, Manitoba, PEI and Newfoundland.

23 We base our estimation on 2001 employment Data. Provincial employment data are not available for many highly vulnerable industries and the coverage is quite poor, particularly for the smaller provinces. For industries where employment data are unavailable, we apply a province-specific, jobs-to-exports ratio based on the assumption that highly vulnerable exports have similar ratios within each province. We use the jobs-to-exports ratio associated with seafood manufacturing for PEI, which has no employment data for any of its highly vulnerable industries. We multiply this province-specific ratio by the value of vulnerable exports at risk to come up with tentative numbers of vulnerable jobs by province. We used province-specific ratios, rather than national ratios, to account for industrial and export intensity differences among provinces.

What Happened After September 11, 2001?

How reliable are our vulnerability rankings and the measures of economic impact we derive from them? In turning to that question, we note that, while we feel these rankings capture five key dimensions of vulnerability to a closed border, they are largely untestable except through a series of terrorist incidents that would simultaneously affect a wide range of goods exports and modes of transport. Happily, no such evidence is available. The events immediately following September 11, 2001, are all we have to go on in seeking evidence about the correlations of our rankings with actual experience.

In looking at those events, we are able to make some adjustments for other developments, such as a cyclical downturn in the North American economy, which occurred at that time. The specific set of reactions to those attacks, however, means that we do not get a clear picture of vulnerability to disruptions that would occur in the wake of a different event. As always, the available data also impose limits. Employment numbers are not available to match all the categories of exports; some quarterly and annual data are still not available in usable form and monthly export data may mask the dislocations caused immediately after September 11, 2001.

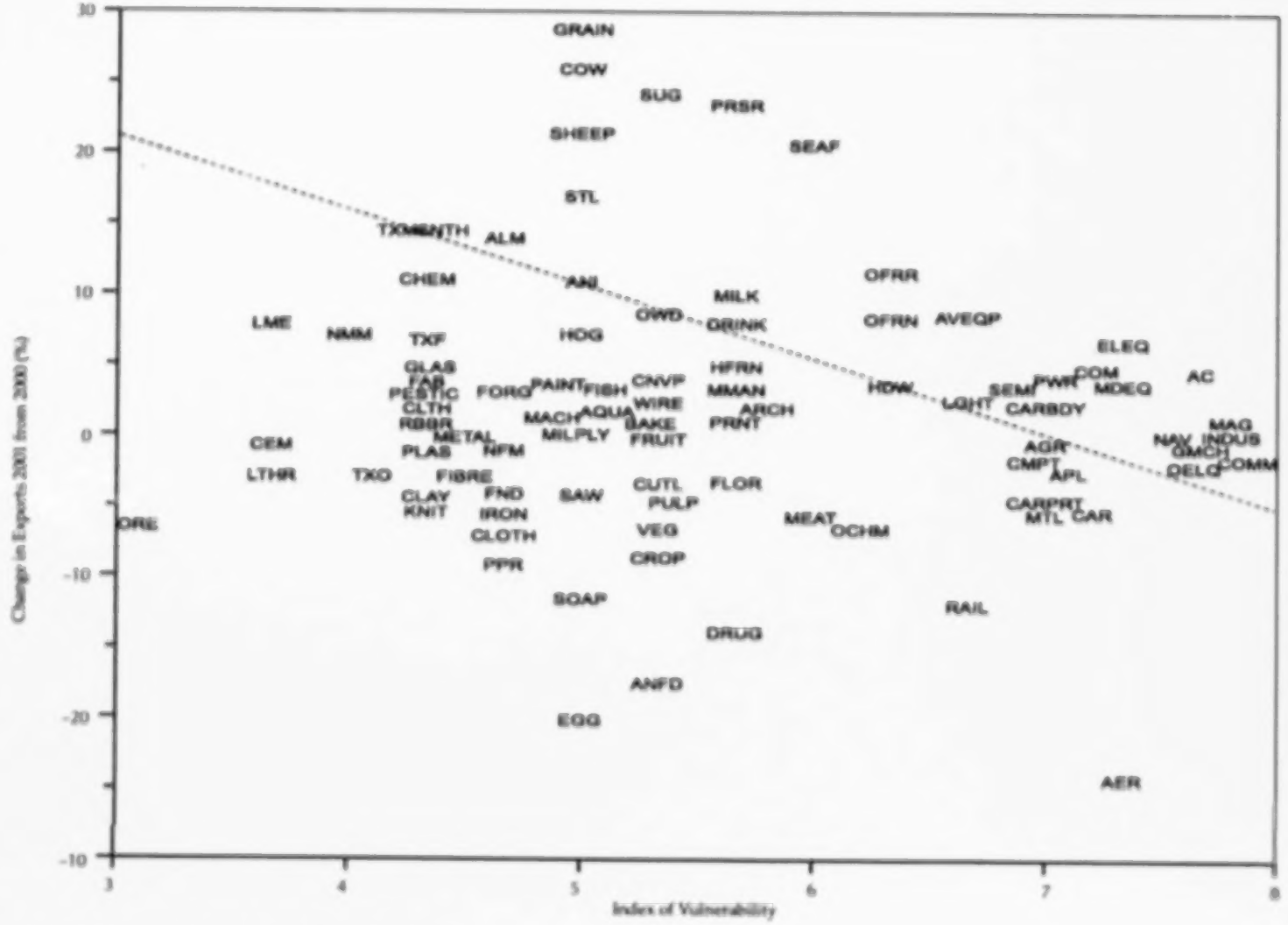
Exports

An obvious place to start the investigation is with exports themselves.[24] Vulnerability will not necessarily be signalled by large and sustained declines in exports, since some industries that were particularly vulnerable likely devoted extra effort and expense to getting their shipments through the obstructed border.[25] Also, there is no way to calculate the volume or value of less vulnerable shipments that may become subject to disruptions if they are backed up, or displaced, by more vulnerable ones, though the mode of transport category may capture some of these effects. Because the terrorist attacks primarily provide evidence on temporary disruptions to exports, we drop two elements of our vulnerability index for this investigation. Location sensitivity would not affect exports in the short timeframe we are considering. And some time-sensitive goods may have moved faster than their less time-sensitive counterparts on that occasion, making the impact of this variable on shipments unclear. Because we wish to control for the possibility that seasonal factors, changes in the overall economic climate and price movements will make dollar values of exports hard to interpret, we compare the year-over-year change in value of each export category between September 2000 and September

24 The choice of category codings involves some awkward tradeoffs. Price and volume breakdowns of trade data are available using the Harmonized System (HS) categories; however, the most readily available aggregations are not suitable for our purposes and these data complicate efforts to trace the effect on employment. Because monthly export data on a NAICS basis are in nominal dollars, both price and volume changes will affect the figures. See Appendix B for a chart highlighting the trade-offs involved in our data selections.

25 For example, DaimlerChrysler used a cross-border rail shuttle service set up by the Canadian Pacific Railway to transport plant-stopper components normally shipped by trucks over the border (Canadian Pacific Railway, 2002). We are grateful to Dan Trefler for discussion on this point.

Figure 3: Vulnerability and Change in Exports: 2001 from 2000: — September vs. August-October



Source: Authors' calculations; Industry Canada Trade Data Online.

* Only changes in exports greater than 30 percent are shown and some points have been moved slightly so that all labels are legible. The regression line is calculated on all exports with changes of less than 100 percentage points.

2001 to the year-over-year change between the average for August and October 2000 and for August and October 2001.[26]

The result is shown in Figure 3: vulnerability scores (averages of our indexes for mode of transport, physical security and people sensitivity) are on the horizontal axis, and changes in export growth are on the vertical axis.

The first point to note about Figure 3 is the diversity of experience from industry to industry. Overall, the value of merchandise exports to the United States dropped 1.4 percentage points more between September 2000 and September 2001 than it did between the comparison periods (August-to-October 2000 and August-to-October 2001). A large number of export industries, however, fared better than during the comparison periods — the difference in year-to-year growth was positive for 60 of the 108 categories we measure here — and in some cases the margin was dramatic.

Within this varied picture, there is some evidence that industries rated as more vulnerable by our measure did relatively worse. The figure shows a tendency for less-vulnerable industries (toward the left) to record better September results (toward the top), while those more vulnerable (toward the right) recorded worse ones (toward the bottom). The dotted trend line in Figure 3 shows the statistical relationship between vulnerability and changes in exports calculated from all industries with changes in year-to-year shipments of less than 100 percentage points (since some smaller categories occasionally have monthly readings that are very small or even zero, resulting in massive percent changes).[27]

Overall, the value of merchandise exports to the United States dropped 1.4 percentage points more between September 2000 and September 2001 than it did between the comparison periods.

Income Statements

Ideally, the income statements of various industries would provide evidence about the correlation of our rankings with adverse effects following the terrorist attacks. Vulnerable industries, especially those that made extra efforts to move affected goods, would probably have seen their operating margins compressed by a mixture of lower revenues and higher costs and the higher costs of transportation services would probably have persisted for some time as negotiated prices changed to reflect some costs that shippers initially absorbed.

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26 At least two implications of this approach warrant comment. First, differences in the number of working days may affect some exports and there was one fewer working day in September 2001 than in September 2000 (there were the same number in both Augusts and one more working day in October 2001 than in October 2000). Second, the impact of the border disruption likely dissipated faster in some affected categories than in others; if disruptions were still affecting some industries but not others after the end of September, using October-over-October figures as a control will distort the results.

27 We get similar results when we perform a regression comparing the changes in Septembers to those in August. As another check, in addition to regressing on the average vulnerability index, we perform a multiple regression using the individual indexes. We find that the coefficient on people sensitivity is high and the other variables do not really come in strongly; their coefficients are small compared with their standard errors, but the correlations among our vulnerability indexes mean that not much should be made of this result. When we regress on each of the indexes individually, we find that all coefficients are small and negative as we might expect. The strongest results are for people sensitivity and physical security.

Although there is evidence that the attacks contributed to higher worldwide transportation expenses,[28] data limitations make it hard to say much about the effects for particular Canadian industries. Cost breakdowns detailed enough to show transportation exist only on an annual basis. Quarterly income-statement data are also awkward: they are too aggregated to enable industry-export matching and have the further disadvantage that, because the attacks occurred toward the end of the third quarter, there is no obvious comparison period. Cash operating margins — revenue from sales less cash operating expenses — in manufacturing deteriorated between the third quarters of 2000 and 2001 by more than they did between the quarters bracketing them (the averages of the second and fourth quarters of 2000 and of 2001). But without data fine-grained enough to permit a comparison of margins by export category, we cannot distinguish between changes in margins arising from border disruptions and those attributable to other industry characteristics, such as different ratios of fixed to variable costs at a time of weakening demand.[29]

Transit Times

Another way to gauge the extra costs incurred after the attacks is to look at time delays and assess how concentrated they were for highly vulnerable and highly valuable industries. Such costs are potentially very important: the Ontario Trucking Association estimates that it costs $65-to-$75 per hour to operate a truck and Hummels (cited in OECD, 2002) estimates that an extra day of shipping time is worth on average 0.5 per cent ad valorem.

According to a May 2002 survey of 31 cross-border truck carriers, they experienced a 20-percent increase in border delays crossing southbound and 12 per cent northbound, compared to May 2001. Most of the participants in the survey carried machinery and equipment, industrial goods and petrochemicals. Over half carried either high-risk goods, such as hazardous materials, or high-value goods such as just-in-time or perishable items (KPMG, 2002). Because the surveyed carriers chose to participate in the survey and are probably more likely than others to have found delays to be long, they may overstate the disruptions faced by carriers on average, though they are likely indicative of the delays faced by highly vulnerable and valuable industries.

Transport Canada has undertaken a pilot study in Ontario, based on an auto-sector company and a food-industry company — both industries that we rank as highly vulnerable — to track transportation times from point of origin to destination between December 2000 and April 2002 for the carrier of food products and from January 2002 to April 2002 for the carrier of automotive products, using GPS transponders and other tracking technologies. Although the complete results

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28 According to the OECD (2002), worldwide transportation costs, in particular the cost of airfreight, stabilized six months after the attacks. But the sharp drop in aggregate demand since 2000 and the drop in fuel costs following the attacks should have led to a steep decline in freight costs, suggesting that the attacks, in fact, contributed to higher transportation costs.

29 Monthly data on inventories do not show any obvious pattern attributable to border-related slowdowns in shipments.

are not available at the time of writing and the study is based on a sample of 3,400 one-way trips, preliminary evidence shows that there was no statistically significant difference between transit times in the months before and after September 11, 2001, at the Ambassador, Queenston-Lewiston and Bluewater bridges.[30]

Awkwardly, this evidence may also be "contaminated" by temporary measures that would not apply to a more sustained situation of heightened security. Border delays and therefore transit times might have been much worse at the end of 2001 had it not been for the extra presence of the U.S. National Guard at the border. When these extra agents were removed in July 2002, delays became more frequent and their length more variable, despite traditionally lower truck volumes in July.[31] The increased personnel to handle border movements may also have muted the expected relationship between vulnerability and falls in export levels.

Equity Prices

Another type of information that could shed light on the impact of border disruptions after the attacks is share prices. Unlike some of the data we have examined so far, which might not convey information about time-sensitivity or substitutability of U.S. production, share prices ought to convey information about all aspects of vulnerability.

At its post-attack trough on September 21, the TSE 300 had fallen more than 11 percent.

We try to distinguish the impact of border disruptions from other effects of the terrorist attacks on the economic outlook in two ways. For one thing, we compare the behaviour of the prices of shares in border-dependent industries with those of shares in less border-dependent ones. We also compare Canadian and U.S. stock indexes on the basis that Canadian share prices are more likely to capture vulnerability to border disruptions than U.S. prices, given the proportionally greater importance of border-related trade to the Canadian economy.

We start by examining the behaviour of those stock sub-indexes with products that feature prominently in cross-border trade. Figure 4 illustrates the behaviour of these selected Toronto Stock Exchange indexes relative to the TSE 300 Composite Index in the aftermath of the attacks. All indexes are re-based so that their September 10 close equals 1.00.[32]

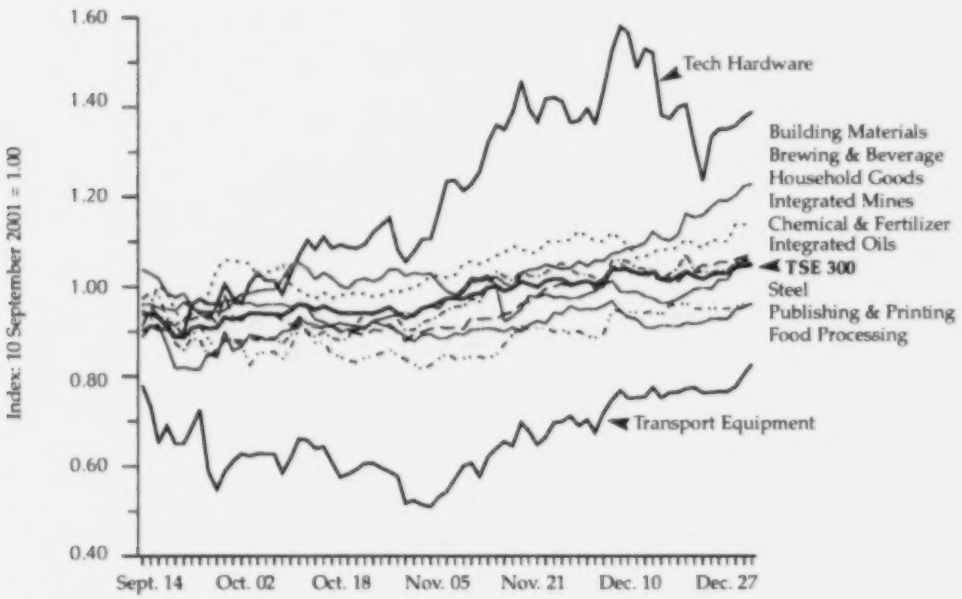
The TSE 300 fell after September 11, with a large number of sector-specific concerns overlaying a generally gloomy assessment of the attacks' expected impact on the economy. After trading resumed on September 14, the index closed down a little more than six percent from its level on September 10 and at its post-attack trough on September 21, it had fallen slightly more than 11 percent. As Figure 4 illustrates, the index regained its pre-attack levels by mid-November and finished the year roughly five percent above its September 10 close. Interestingly, the most trade-sensitive sectors did not fall dramatically more than the overall index, which

30 The null hypothesis that the mean crossing times from December 2000 to September 11, 2001, and September 12, 2001, to April 19, 2002, was the same was not rejected at the 95-percent confidence level.

31 We thank Stephen Laskowski of the Ontario Trucking Association for this information.

32 We use share-price indexes rather than total return indexes, which could affect our comparisons.

Figure 4: TSE Sub-Indexes after September 11, 2001



Source: StockVal; authors' calculations.

was itself sent lower by declining share prices among financial-services companies, department stores and hospitality industries in the wake of the attacks. Transportation equipment was an exception; the sub-index fell relatively sharply immediately after the attacks and still had not reached its pre-September 11 level by the end of the year.

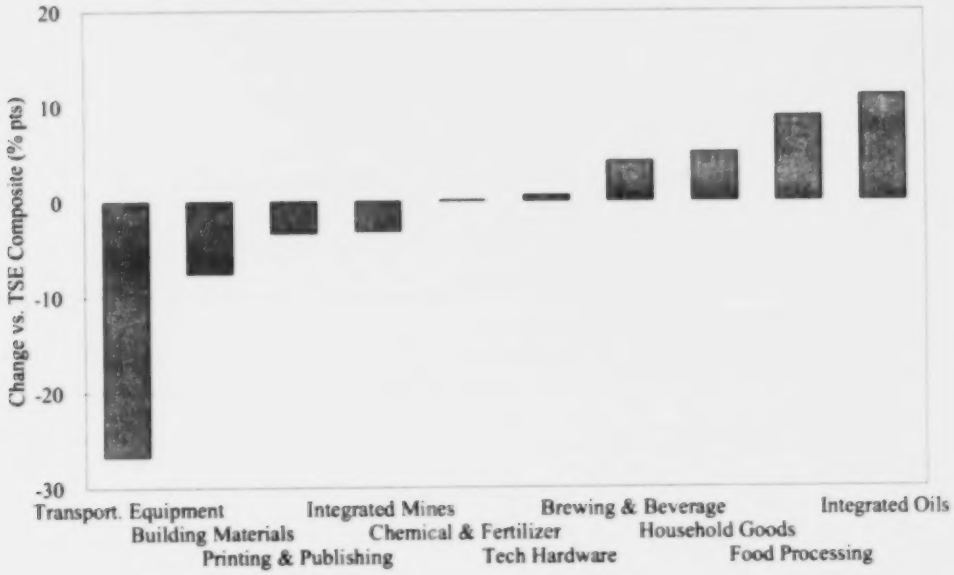
The post-attack trough seems an obvious point at which to compare share prices. It is long enough after the attacks for much of the initial confusion at the border to have dissipated, but short enough that the attacks should still have a major influence on prices. Figure 5 shows how the same sub-indexes illustrated in Figure 4 had moved by September 21 relative to the TSE 300.

The high level of aggregation of share indexes makes it difficult to see whether new assessments about the border specifically had a decisive influence on investor perceptions. Transportation equipment, which we rate as relatively vulnerable, performed worst and oil producers, which we rate as relatively invulnerable, performed best. But some of the other relatively well-performing indexes would not, on our assessment, have fared well if investors saw border considerations as critical.

Border considerations might also result in declines in the price of shares in Canadian companies relative to those in U.S. companies engaged in the same line of business. Unfortunately we do not have industry data for U.S. sub-indexes that correspond to our TSE 300 sub-indexes and, as a second-best option, we compare the performance of the S&P 500 index to that of the TSE 300. Figure 6 shows the performance of the TSE relative to the S&P (both rebased so that their September 10 close equals 1.00) in the aftermath of the attacks.

On the face of it, one might expect the index in the country that was attacked to fall by more than the one in Canada. Interestingly, relative to September 10, the TSE

Figure 5: Performance of TSE Sub-Indexes Relative to Composite: September 10–21, 2001.



Source: Authors' calculations; StockVal.

300 fell by more than the S&P composite for most of the month following the attacks, though the difference in the relative size of the declines was small. The underperformance of the Canadian index might reflect the fact that Canadian equity markets are more leveraged to global demand than are U.S. markets because of the greater importance of resource industries in Canadian output, as well as the possibility that investors considered border disruptions to be problematic and disproportionately lowered their expectations for earnings in Canada.

Employment

Did September 11, 2001, have any noticeable immediate impact on jobs in the affected industries? In answering this question, we are able to draw on monthly data that better match the export categories.[33] We use the same type of comparison — changes in employment from September 2000 to September 2001 versus changes between the August-October average for 2000 and for 2001 — which we used for trade.

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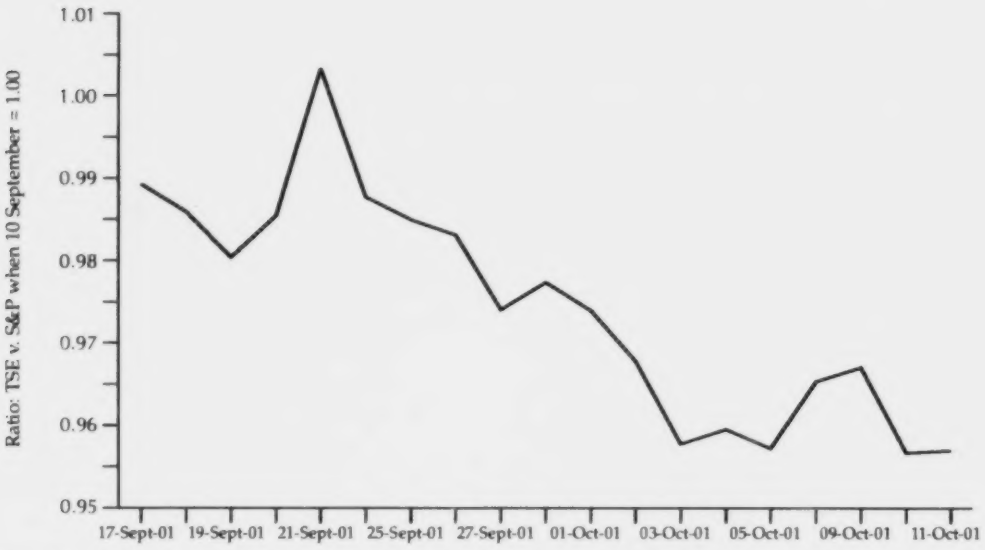
33 Employment data for selected industries only are available from Statistics Canada. However, these selected industries tend to represent the higher value categories. Data are from the Survey of Employment, Payrolls and Hours and are not seasonally adjusted. Since the reference period for this survey is the last week of every month, the September 2001 data would capture consequences of the border disruptions and the October 2001 data would capture the situation a month and a half after the attacks.

Figure 6: TSE 300/S&P 500:
Change Relative to September 10, 2001



Source: StockVal; authors' calculations.

Overall employment dropped by only 0.3 percentage points more between September 2000 and September 2001 than it did between the comparison periods. As with our export data, there is considerable diversity of experience from industry to industry. While 24 of the industries in our employment sample declined by more than the overall figure, 38 fell by less; most showed job growth.

Although there is a slight tendency for industries rated as more vulnerable to show worse employment numbers, the correlation is not tight.[34] Some industries rated as more vulnerable by our measure do relatively worse. Motor vehicles and parts manufacturing, semiconductor and other electronic component manufacturing, as well as food processing, are all export-intensive industries that showed disproportionate employment losses. Again, however, it is possible that vulnerability to disruptions resulted in short-run efforts that would confound the expected longer-run relationship. Employment in many industries in the upper right corner of Figure 2 (employment data are available for 21 of the 25) did *better* than the overall average. One possible reason for the better results in those industries is that vulnerable industries were willing to make special efforts to get merchandise shipped. Such a response would obviously not accurately forecast the impact of prolonged actual or expected border disruptions.

34 Since we are interested in temporary disruptions, we use the same measure as for our export analysis, dropping time- and location-sensitivity from the index.

Investment

Statistics Canada's survey of investment intentions for 2002 collected responses from October to January.[35] The October 2001-to-January 2002 period captured in the data was one when potential border disruptions would have been much on the minds of executives. Overall, when comparing intentions for 2002 to figures for 2001, industries rated as more vulnerable by our measure registered relatively larger declines. The same is true when comparing intentions for 2003 to figures for 2001. Investment for all industries rose by an average of 2 percent from 2001-to-2002 and by an average of 4 percent from 2001-to-2003. By contrast, investment in vulnerable industries fell by an average of 13 percent from 2001-to-2002, and though it rebounded slightly in 2003, overall it declined by an average of 9 percent from 2001-to-2003. It is worth emphasizing that many factors other than the border influence these figures, and patterns within groups show striking variations; while the survey showed sharp investment reduction in communications equipment manufacturing, for example, it indicated an increase in auto parts investment for 2002 and then an anticipated decline in 2003. It would be interesting to include in future surveys a question that could help distinguish different reasons for changes in investment levels to determine how important the perceived permeability of the border is, relative to other key factors, such as the state of demand in an industry, changes in taxation or the launching and completion of major projects.

Implications and Options

To this point, we have devised a measure of the vulnerability of various Canada-U.S. exports to border disruptions, provided some rough estimates of the size of the threat this vulnerability represents to Canadian jobs and investment, and examined the actual impact of the September 11, 2001-related disruptions on various measures of activity. Data limitations and the particular nature of the September 11, 2001, attacks and their aftermath make it difficult to subject our vulnerability rankings to a proper test.

Implications

We do feel, however, that they provide a useful background for some observations about the policy implications of Canada's economic vulnerability.

The Stakes for Canada are High

The key starting point for our observations is that Canadians have an enormous economic stake in limiting future security-related disruptions to cross-border trade. The 390,000 Canadian jobs and the $3.7 billion in Canadian investment that are represented in the "hot corner" of Figure 2 indicate the scale of activity in Canada

35 No comparable data exist on investment intentions by foreigners. Actual FDI for 2001 showed large increases for three of the four industry categories that correspond more closely to our most vulnerable group: transportation equipment, machinery and equipment and electronics. Actual data for 2002 will not be available for some time.

that would be affected if the border began to look like a major obstacle separating producers from their markets. As the new Department of Homeland Security takes shape, we should anticipate more border controls, increasing the likelihood of security-related border disruptions.

The point about the scale of activity that is potentially vulnerable is worth emphasizing, because there is a danger that Canadians' tendency to see economic issues as central to border management can lead them to downplay the U.S. preoccupation with security, without adequate attention to the fact that Canada's economic vulnerability is intimately tied up with U.S. security concerns. If Canadians, as business managers and policymakers, do not address U.S. security concerns in ways that are both effective and high profile, protests about economic damage will carry little weight in the face of another threatened or actual terrorist attack.

Security "Spillovers" and the Case for Collective Action

Thinking about how to protect Canada's economic interests by addressing U.S. security concerns requires distinguishing between problems that are susceptible to private solution and those that require collective action. The key here is the familiar idea of spillovers. Exporters and others who bear the full cost of security risks related to their own shipments are likelier to invest sufficiently in security-enhancing measures than are exporters and others who, should they create security-related risks, will impose at least some of the resulting costs on others. The case for collective action arises when the decisions of one individual, business or government do not take full account of externalities, including the costs or benefits imposed or conferred on other individuals, businesses or governments.

One spillover is the exposure of individual Canadian exporters to border problems caused by other exporters.

One important spillover that matters here is the exposure of individual Canadian exporters to border problems that arise because of security-related risks caused by other exporters. If this exposure is limited to an industry or cluster of related industries where the number of companies is relatively small, companies may be able to undertake collective action in response. In those cases, the imperative for government is mainly to ensure that it does not impede these private-sector collaborations.

Where the number of companies in an industry is large, by contrast, the fact that some benefits from each one's investments in security are enjoyed by others may make the overall investment in security lower than the companies would undertake together if they could coordinate. Possible policy responses include compulsory insurance coverage for a sector: risk premiums for such coverage will provide an incentive for each business to improve its own security measures.

A similar problem arises when exporters in one industry expose those in an unrelated industry to risks arising, for example, from delays in a commonly used mode of transport. Here also, governments could help overcome coordination problems by, say, investing in improved screening technology to divide low-risk from high-risk shipments, fast-tracking exports from companies that make investments in their security, moving functions away from the border towards point of entry into North America or point of origin, or by expanding the capacity of transportation infrastructure. We note that responsibility for these investments is

not necessarily federal. The first three of these functions are appropriately carried out by the federal government; the last is at least as much a provincial- and local-government concern, which implies a larger provincial or local role in more border-dependent provinces, such as Ontario, Quebec and Manitoba.

The most critical externality of all is the risk that neither Canada nor the United States invests adequately in security measures that help protect the other against attack. Each country has a legitimate interest in ensuring that the other devotes the same resources to protecting its neighbour's citizens that it does to protecting its own. If that assurance requires common policing of embarkation and entry points to North America, or at overseas points of origin, Canadian concerns about sovereignty must be tempered with consideration that reassuring the United States is an indispensable condition for keeping the border open.

Options

In more than a year since the terrorist attacks, much has been done to address the security-related concerns that threaten commerce across the border. A major outstanding question, which will become more acute if the political support for security measures fades in Canada, is whether the resulting improvements in security will be effective enough and visible enough to Americans to reduce Canadian vulnerability in the event of another attack.

Incremental Steps

Among the key actions undertaken by Ottawa since September 2001 are new immigration and anti-terrorism bills, an allocation of $1.2 billion in the December 2001 federal budget for "border security and infrastructure" and a joint announcement with the U.S. government of the Smart Border Declaration (SBD) in December 2001.[36] Progress to date includes the opening and expansion of the NEXUS program, which had been suspended after the attacks, to speed low-risk travellers through the border,[37] joint posting of customs officials to oversee marine containers destined for either country at their first port of arrival in North America,[38] joint posting of customs and immigration officials at Vancouver and Miami airports, and an agreement to formally consult each other in developing the list of countries whose citizens require visas. The governments have also signed a safe third-country agreement, requiring that refugee claimants apply in the first of the two countries in which they arrive. As well, the countries are implementing a common approach for the screening of international air passengers and working on common standards for biometric identification (United States, 2002).

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36 For a complete description of progress on the SBD, see United States, 2002.

37 Participants in NEXUS are pre-approved by both Canada and the U.S. as low-risk travellers who use dedicated lanes at border crossings and are not regularly subject to the usual customs and immigration questioning.

38 Despite the joint posting of officials, adding an extra car to a train already cleared at a port may make the initial inspection invalid from a security perspective.

In terms of container security, Canada and the United States have committed to "deploy interoperable technologies in support of other initiatives to facilitate the secure movement of goods and people, such as transponder applications and electronic container seals." In November 2002, the U.S. government introduced Operation Safe Commerce, a program to fund business initiatives designed to make the U.S. container-cargo system more secure. Transport Canada is monitoring this program and the Canadian government is undertaking a study of security and the marine transportation system in order to develop a national marine security strategy. In March 2002, Canadian and U.S. officials came to an understanding for pre-screening of vessels before they arrive in the St. Lawrence Seaway and Great Lakes systems and for onboard inspections of vessels before they proceed to port.[39] A new bi-national Planning Group was announced on December 9, 2002.[40] The government also announced additional funding for maritime security in the February 18 federal budget. Canada has also committed $50 million in fiscal 2003/04 and $25 million in 2004/05 towards a Security Contingency Reserve, which could include border security. All these actions address externalities presented by security-related threats at the border.

The Canadian and U.S. governments have also implemented the Free and Secure Trade (FAST) program, which is intended to encourage businesses to invest in their own security by providing them with dedicated lanes and expedited clearance at the border after importers, shippers, carriers and drivers have all been pre-approved. The program is based on the Canadian Customs Self Assessment (CSA) program. To date, few companies have made the investments required under the CSA to take advantage of the expedited clearance, although the auto industry, a relatively vulnerable one, is a notable exception. If the FAST program does deliver expedited clearance, businesses that are highly vulnerable or valuable will be the primary beneficiaries and will, therefore, have the greatest incentives to internalize these security costs. Governments in this case play an appropriate facilitative role, and should ensure that companies are aware of this option, and that dedicated lanes are in place far enough away from the border to make the program effective.

If rules of origin cannot be eliminated, one step in a similar direction would be identifying the level of risk of shipments, based on place of origin.

Looking ahead, eliminating or moving border functions could build on existing SBD initiatives. Hart (2002) has suggested that harmonizing tariffs for the thousands of products for which the levels of Canadian and U.S. duties against third countries are already close would eliminate the need for complicated "rules of origin" tracking by border officials, facilitating traffic and allowing resources to be redeployed on security risks. Common tariffs would also assist the establishment of joint customs inspections, which would facilitate traffic of goods between Canada and the United States, and could have a confidence-building effect as the countries' officials got used to working together.

If rules of origin are too hard to eliminate, one step in a similar direction could be establishing low-, medium-, and high-risk categories of shipments, classified by place of origin. This distinction could enable more focussed inspections, and encourage companies to invest in the necessary security measures in proportion to

39 Transport Canada email communication with the authors, November 28, 2002.

40 "Canada and the U.S. Enhance Security Cooperation" <www.canadianembassy.org/homepage/index-en.asp, visited December 10, 2002>.

the risks their shipments involve.[41] Importantly, moving functions away from the border towards points of entry into North America need not imply uniform laws and standards. Mutual recognition of key standards — as in the European Union, where national standards vary more than they typically do between Canada and the United States — could enable goods cleared for Canada to be fast-tracked at the border.

There are other avenues for improving the resiliency of cross-border commerce in the face of security threats. In September 2002, the Canadian and Ontario governments committed $300 million over five years as part of a joint investment to upgrade existing infrastructure on the Ontario approaches to the Windsor-Detroit border crossings. In March 2003, the Canadian and B.C. governments committed $211 million for eight highway accesses leading to border crossings. Further infrastructure investments, such as additional capacity at the Peace Bridge between Fort Erie and Buffalo or the bridge linking Sarnia and Port Huron, with more easily accessed, dedicated commuter lanes, would also help (Papademetriou and Meyers, 2001). There is scope for further within- and between-country integration of databases dealing with immigration, customs, law enforcement, public health and intelligence activities.

A Larger Framework

Effective though such incremental steps are, their lack of profile and technical nature pose risks. The easy items on the SBD agenda have been agreed and implemented. The complexities of the U.S. political system and the less security-oriented attitude in Canada mean that further progress, for example, on moving border functions away from the border will be increasingly difficult. If and when the SBD is fully implemented, U.S. priorities are likely to shift elsewhere, leaving many of the border vulnerabilities we have described little changed.

In the event of another attack, moreover, Canada will again be a target of U.S. complaints, partly because of legitimate concerns about inadequate security north of the border, but also because many Americans will be reluctant to accept blame for failings on their own side. In the current sensitive context, one small security flare-up linked to Canada could have major economic consequences. A key drawback of incremental measures in strengthening border security is that they do not create headlines and register with opinion leaders; as a result, Canada risks getting little credit for the improvements it makes.

The need for a broader, more compelling agenda that can attract business and political support on both sides of the border underlies proposals for a larger agreement on North American economic and security integration, such as a "strategic bargain for physical and economic security" (Dobson, 2002) a "grand bargain" (Gotlieb, 2003) and a "common frontier" (Hufbauer and Vega-Canovas, 2002). Such a vision is compatible with continued incremental progress — indeed, it may be the most effective way of preserving the momentum behind incremental improvements. Such a vision must make security its focal point in order to attract

41 We are grateful to Chris Sands for discussion of this point.

U.S. attention and especially the attention of the U.S. Department of Homeland Security. Given the size of the economic stakes for Canada, and the substantive and optical drawbacks of an exclusively incremental approach, a loud and unequivocal high-level announcement that Canada treats the security of Americans no less seriously than it treats the security of Canadians, combined with a larger approach to enhance North American physical and exonomic security, are appropriate priorities for Canada's federal government.[42]

Conclusion

Our assessment of the vulnerability of Canada-U.S. exports to security-related disruptions shows that large amounts of trade and associated jobs and investment are vulnerable in the event of future threats or actual acts of terrorism. Although data limitations and the particular nature of the events of September 11, 2001, make firm conclusions difficult, our measures receive some support from indicators of trade flows and other economic activity following those attacks. If our assessment is correct, effective "thickening" of the border by extra security measures threatens to deprive Canada of the advantages — in particular, investment by producers seeking to serve the entire North American market — that trade liberalization within this continent has conferred.

The federal government should acknowledge loudly and clearly that better border security is essential and make that statement the centrepiece of a major effort to enhance safety.

The appropriate response to this vulnerability varies by industry, location and level of government. In many instances, individual companies and industry groups can make and are already making necessary investments. In others, coordination problems require governments to induce extra security-oriented investments. And there is a clear case for public investments in infrastructure and border security that will expand the capacity of chokepoints and shift resources away from inspections that slow down legitimate trade and toward activities that will detect and neutralize security threats. There is also a case in favour of moving border functions away from the Canada-U.S. frontier towards points of entry into North America or towards points of origin.

The clearest case for public action arises from the mutual vulnerability of Canada and the United States to security lapses in the other country and, more particularly, from U.S. concern that inadequate Canadian attention to security issues poses a threat to U.S. citizens. Incremental improvements to border security, no matter how effective, may fail to register with U.S. leaders and opinion-makers, depriving the project of momentum and raising the risk that a future threat or act of terrorism will cause disproportionate harm to Canadian trade. The United States has been, and will probably continue to be, relentless in the pursuit of both perceived and actual weak links. The federal government should acknowledge loudly and clearly that better border security is essential and make that acknowledgment a centrepiece of a major effort to enhance North American physical and economic security. Our work on the vulnerability of exports to

42 Given the unique set of issues on the Canada-U.S. border, it would probably make more sense to pursue a bilateral Canada-U.S. framework that would be open to, but not require, Mexican accession.

security-related disruptions illustrates that the costs for Canada of not doing so would be very high indeed.

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Appendix A: ***Indexes of Vulnerability to Border Disruptions***

NAICS 4-Digit Description	NAICS 4-Digit Code	Mnemonic	Physical Security (1-10)	Mode of Transportation (1-10)	Time Sensitivity (1-10)	People Sensitivity (1-10)	Location Sensitivity (1-10)	Overall Index of Vulnerability (1-10)	Total Domestic Exports to U.S. (2001; $mn)
Oilseed and grain farming	1111	GRAIN	4	10	3	1	1	3.8	1,169
Vegetable and melon farming	1112	VEG	5	10	9	1	4	5.8	655
Fruit and tree nut farming	1113	FRUIT	5	10	7	1	3	5.2	119
Greenhouse, nursery and floriculture production	1114	FLOR	6	10	9	1	7	6.6	560
Other crop farming	1119	CROP	5	10	9	1	3	5.6	228
Cattle ranching and farming	1121	COW	4	10	10	1	7	6.4	1,666
Hog and pig farming	1122	HOG	4	10	10	1	7	6.4	555
Poultry and egg production	1123	EGG	4	10	10	1	9	6.8	51
Sheep and goat farming	1124	SHEEP	4	10	10	1	7	6.4	14
Animal aquaculture	1125	AQUA	4	10	9	1	4	5.6	436
Other animal production	1129	ANI	4	10	9	1	6	6	154
Forest nurseries and gathering of forest products	1132	FOR	4	10	5	2	2	4.6	8
Logging	1133	LOG	4	9	3	1	4	4.2	104
Fishing	1141	FISH	4	10	10	1	1	5.2	750
Hunting and trapping	1142	HUNT	4	10	4	1	1	4.0	5
Support activities for crop production	1151	SUPC	7	10	7	9	7	8.0	0
Support activities for animal production	1152	SUPA	7	10	7	9	7	8.0	21
Oil and gas extraction	2111	OIL	1	1	9	1	1	2.6	41,911
Coal mining	2121	COAL	3	4	3	1	1	2.4	200
Metal ore mining	2122	ORE	4	4	3	1	1	3.0	2,001
Non-metallic mineral mining and quarrying	2123	MIN	3	4	3	1	1	2.4	1,753
Electric power generation, transmission	2211	ELEC	1	1	9	1	9	4.2	4,220
Animal food mfg	3111	ANFD	5	10	7	1	9	6.4	410
Grain and oilseed milling	3112	MIL	4	10	4	1	1	4.0	1,268
Sugar and confectionery product mfg	3113	SUG	5	10	6	1	9	6.2	1,207
Fruit and vegetable preserving and specialty food mfg	3114	FRSR	6	10	6	1	10	6.6	1,271
Dairy product mfg	3115	MILK	6	10	10	1	7	6.8	211
Meat product mfg	3116	MEAT	7	10	9	1	7	6.8	3,405
Seafood product preparation and packaging	3117	SEAF	7	10	9	1	7	6.8	1,876

NAICS 4-Digit Description	NAICS 4-Digit Code	Mnemonic	Physical Security *(1-10)*	Mode of Transportation *(1-10)*	Time Sensitivity *(1-10)*	People Sensitivity *(1-10)*	Location Sensitivity *(1-10)*	Overall Index of Vulnerability *(1-10)*	Total Domestic Exports to U.S. *(2001, $mn)*
Bakeries and tortilla mfg.	3118	BAKE	5	10	7	1	10	6.6	1,022
Other food mfg.	3119	FDMNF	6	10	7	1	9	6.6	1,011
Beverage mfg.	3121	DRNK	6	10	7	1	9	6.6	1,412
Tobacco mfg.	3122	TOB	4	8	5	1	9	5.4	87
Fibre, yarn and thread mills	3131	FIBRE	4	8	3	1	9	5.0	236
Fabric mills	3132	FAB	4	8	3	1	9	5.0	1,190
Textile and fabric finishing and fabric coating	3133	TXF	4	8	3	1	9	5.0	182
Textile furnishings mills	3141	TXM	4	8	3	1	9	5.0	373
Other textile product mills	3149	TXO	4	8	3	1	9	5.0	381
Clothing knitting mills	3151	KNIT	4	8	3	1	9	5.0	596
Cut and sew clothing mfg.	3152	CLTH	4	8	3	1	9	5.0	1,953
Clothing accessories and other clothing mfg.	3159	CLOTH	5	8	3	1	9	5.2	177
Leather and hide tanning and finishing	3161	LTHR	4	6	3	1	7	4.2	31
Footwear mfg.	3162	SHOE	5	6	3	1	9	4.8	105
Other leather and allied product mfg.	3169	OLTHR	5	6	3	1	8	4.6	90
Sawmills and wood preservation	3211	SAW	4	10	3	1	6	4.8	10,192
Veneer, plywood and engineered wood product mfg.	3212	PLY	4	10	3	1	6	4.8	4,023
Other wood product mfg.	3219	OWD	5	10	3	1	6	5.0	1,745
Pulp, paper and paperboard mills	3221	PULP	4	10	3	1	6	4.8	16,456
Converted paper product mfg.	3222	CNVP	5	10	5	1	6	5.4	2,510
Printing and related support activities	3231	PRNT	5	10	3	2	7	5.4	1,609
Petroleum and coal products mfg.	3241	PPR	5	8	3	1	3	4.0	9,274
Basic chemical mfg.	3251	CHEM	4	7	7	2	5	5.0	5,094
Resin, synthetic rubber, artificial and synthetic fibre and filament mfg.	3252	SNTH	5	6	7	2	7	5.4	5,510
Pesticide, fertilizer and other agricultural chemical mfg.	3253	PSTIC	5	6	4	2	7	4.8	1,029
Pharmaceutical and medicine mfg.	3254	DRUG	7	7	7	3	9	6.6	1,781
Paint, coating and adhesive mfg.	3255	PAINT	7	7	5	1	9	5.8	540
Soap, cleaning compound and toilet products mfg.	3256	SOAP	7	7	5	1	9	5.8	6

Appendix A: ***Indexes of Vulnerability to Border Disruptions*** *- continued*

NAICS 4-Digit Description	NAICS 4-Digit Code	Mnemonic	Physical Security (1-10)	Mode of Transportation (1-10)	Time Sensitivity (1-10)	People Sensitivity (1-10)	Location Sensitivity (1-10)	Overall Index of Vulnerability (1-10)	Total Domestic Exports to U.S. (2001, $mn)
Other chemical product mfg.	3259	OCHM	7	8	5	3	7	6.0	1,211
Plastic product mfg.	3261	PLAS	5	7	5	1	7	5.0	7,646
Rubber product mfg.	3262	RBBR	5	7	5	1	7	5.0	3,127
Clay product and refractory mfg.	3271	CLAY	5	7	5	1	7	5.0	119
Glass and glass product mfg.	3272	GLAS	5	7	5	1	7	5.0	953
Cement and concrete product mfg.	3273	CEM	4	6	5	1	6	4.4	773
Lime and gypsum product mfg.	3274	LME	4	6	5	1	5	4.2	205
Other non-metallic mineral product mfg.	3279	NMM	4	6	4	2	5	4.2	841
Iron and steel mills and ferro-alloy mfg.	3311	IRON	5	7	5	2	7	5.2	2,379
Steel product mfg. from purchased steel	3312	STL	5	8	4	2	7	5.2	1,400
Alumina and aluminum production and processing	3313	ALM	5	7	4	2	5	4.6	6,202
Non-ferrous metal (except aluminum) production and processing	3314	NFM	5	7	4	2	5	4.6	4,725
Foundries	3315	FND	5	7	5	2	7	5.2	293
Forging and stamping	3321	FORG	5	7	5	2	7	5.2	760
Cutlery and hand tool mfg.	3322	CUTL	7	7	4	2	10	6.0	423
Architectural and structural metals mfg.	3323	ARCH	5	10	5	2	9	6.2	1,764
Boiler, tank and shipping container manufacturing	3324	TANK	7	10	5	2	9	6.6	886
Hardware mfg.	3325	HDW	7	10	4	2	9	6.4	1,199
Spring and wire product mfg.	3326	WIRE	6	8	4	2	9	5.8	609
Machine shops, turned product, and screw, nut and bolt mfg.	3327	MACH	5	8	4	2	9	5.6	384
Coating, engraving heat treating and allied activities	3328	MTC	5	7	5	2	7	5.2	1
Other fabricated metal product mfg.	3329	METAL	5	7	5	2	7	5.2	1,451
Agricultural, construction and mining machinery mfg.	3331	AGR	9	10	5	2	7	6.6	1,965
Industrial machinery mfg.	3332	INDUS	9	10	6	6	7	7.2	1,847
Commercial and service industry machinery mfg.	3333	COMM	9	10	5	6	7	7.0	2,197
Ventilation, heating, air-conditioning and commercial refrigeration equipment mfg.	3334	AC	9	10	5	6	7	7.0	1,453

Appendix A: *Indexes of Vulnerability to Border Disruptions* - *continued*

NAICS 6-Digit Description	NAICS 6-Digit Code	Mnemonic	Physical Security (1-10)	Mode of Transportation (1-10)	Time Sensitivity (1-10)	People Sensitivity (1-10)	Location Sensitivity (1-10)	Overall Index of Vulnerability (1-10)	Total Domestic Exports to U.S. (2005, $mm)
Metalworking machine mfg.	333515	MTL	7	10	5	4	7	6.6	1,664
Engine, turbine and power transmission equipment mfg.	333611	PWR	7	10	7	4	7	7.0	4,184
Other general-purpose machinery mfg.	333999	GMCH	9	10	7	4	7	7.4	3,857
Computer and peripheral equipment mfg.	334111	CMPT	7	10	9	4	9	7.8	3,998
Communications equipment mfg.	334210	COM	7	10	8	4	9	7.6	6,584
Audio and video equipment mfg.	334310	AVEQP	7	10	8	3	9	7.4	191
semiconductor and other electronic component mfg.	334413	SEMI	7	10	9	4	7	7.4	3,470
Navigational, measuring, medical and control instruments mfg.	334519	NAV	9	10	7	4	9	7.8	1,836
Mfg. and reproducing magnetic and optical media	334610	MAG	9	10	7	4	9	7.8	370
Electric lighting equipment mfg.	335110	LGHT	8	10	7	2	9	7.2	561
Household appliance mfg.	335210	APL	9	10	6	2	9	7.2	1,080
Electrical equipment mfg.	335311	ELEQ	9	10	8	3	7	7.4	2,418
Other electrical equipment and component mfg.	335999	OELQ	9	10	8	4	7	7.6	1,656
Motor vehicle mfg.	336111	CAR	7	10	9	4	9	7.8	62,766
Motor vehicle body & trailer mfg.	336211	CARBDY	7	10	9	4	9	7.8	1,080
Motor vehicle parts mfg.	336312	CARPRT	7	10	10	4	9	8.0	16,773
Aerospace product & parts mfg.	336411	AER	7	10	8	5	9	7.8	10,181
Railroad rolling stock mfg.	336510	RAIL	9	8	4	3	7	6.2	663
Ship and boat building	336611	SHIP	9	9	5	6	7	7.2	700
Other transportation equipment mfg.	336991	TRNPT	9	9	1	5	7	7.4	437
Household and institutional furniture and kitchen cabinet mfg.	337110	HHFN	7	8	5	2	7	5.8	3,457
Office furniture (including fixtures) mfg.	337211	OFFN	7	10	6	2	7	6.4	3,371
Other furniture-related prod. mfg.	337910	OFRM	7	10	6	2	7	6.4	87
Medical equipment and supplies mfg.	339112	MEDQ	9	8	8	5	9	7.8	314
Other miscellaneous mfg.	339999	MMAN	7	8	6	2	7	6.0	2,262

Appendix B: Data Issues

There are three main classification systems for grouping Canadian exports. We use the North American Industrial Classification System (NAICS) because it allows for the most exact matching between exports and other data. The following table identifies the advantages and limitations of available data and illustrates the advantages and limitations of our approach (shaded).

Classification System	Grouped by	Price/ Volume Breakdown Available?	Services Data Available?	Matching Data Available?				
				U.S. Figures	Income Statement	Employment	Output	Investment
Harmonized System (HS)	Commodities	Yes	No	Internationally comparable at 6-digit level	No	No	No	No
The Standard Industrial Classification (SIC). Each HS code is assigned an SIC code.	Industries. Data are available at either the enterprise or the plant level, and these two groupings are not easilycomparable.	No	Services exports available at 1-2 digit level on a quarterly basis.	No	No	No	No	Only at 1-2 digit level on annual basis.
North American Industrial Classification System (NAICS). Each HS code is assigned an NAICS code.	Industries	No	Only for some export codes	NAFTA countries are in process of transferring from SIC to NAICS, which will be comparable across NAFTA	At 2-digit level for all industries, at 3- or 4-digit level for manufacturing industries	Majority of industries available on NAICS basis	Output data are available in System of National Accounts (SNA)-NAICS form. Each SNA -NAICS code concords with one or more NAICS codes	Available in NAICS only for Canadian Investment (not FDI); data for most but not all NAICS 4-digit categories available.

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